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(54) Title: SYSTEM AND METHOD FOR PREVENTING FOULING IN SENSORS

(57) Abstract: In one aspect, an anti-fouling system is described for use with a water quality monitoring sensor that includes a housing with an interior cavity sized for housing a monitoring sensor. The interior cavity also includes multiple ultraviolet light sources disposed within the interior cavity that are able to reduce biota within the interior cavity. in a particular embodiment, the ultraviolet light source are ultravioleta LEDs.

# SYSTEM AND METHOD FOR PREVENTING FOULING IN SENSORS

## TECHNICAL FIELD OF THE INVENTION

This invention related in general to the field of sensors and more particularly to a system and method for preventing fouling in water quality sensors.

## BACKGROUND OF THE INVENTION

Water quality monitors measure a number of variables using sensors. Sensors may measure variables such as temperature, conductivity and salinity, pH and particularly turbidity, chlorophyll, and dissolved oxygen. When left unattended sensors often tend to become fouled with sedimentary, suspended, or biological materials from the water of the lake, river, estuary, or body of water in which the sensor is deployed (immersed). The result of such fouling includes drifting and inaccurate water quality data. Accordingly, personnel are required to go to the field site and either clean and re-deploy the sensors, or replace the sensors with a cleaned and calibrated instrument. Lengthening the time for which water quality monitors can be deployed reduces the frequency that personnel must visit a site thereby increasing safety and data quality.

When the application is environmental rather than process monitoring, the cost of personnel to maintain the sensors is proportionally high and would benefit significantly from sensors with improved fouling-resistance. For example, if a water quality sensor is

now limited to one-week deployment periods, extending the deployment period to two weeks would roughly halve operational costs for the resulting water quality data. In addition, extended deployment capability might result in new market opportunities as more deployment scenarios become economically feasible.

Current methods for attempting to reduce sensor fouling, thereby extending deployment times include: leaving the sensor dry, using chemical poisons such as chlorine compounds, antifoul paints, antimicrobial surface treatments, and inhospitable construction materials. Each of these techniques has significant limitations such as toxicity restrictions, cost, size, and questionable durability.

Other attempts to extend deployments have involved mechanical devices to remove deposited silt, grit, biological (algal, fungal, or bacterial) films or oil/grease layers. The brushes, wipers, skimmers, and similar mechanisms employed have several draw backs, including an often large size, excessive power consumption, and, because of moving parts associated with the devices, a tendency to wear or fail before the sensors have reached the end of their useful lives. Also, some delicate sensors such as turbidity sensors may experience damage from scraping away grit from the sensor surfaces.

Another popular cleaning method is the use of air jets to blow away fouling materials. This method, which requires either a compressed-air supply or an air compressor with access to air, is not suitable for

deployments in natural waters where space, power, cost, and unobtrusiveness are critical.

In the process monitoring industry, ultrasonic sensor cleaners are sometimes used. Size and power requirements make this technique unfeasible for deployment in environmental applications.

## SUMMARY OF THE INVENTION

Therefore a need has arisen for a system for preventing fouling in water quality sensors that is suitable for deployment in natural waters.

A further need has arisen for a system and method for preventing fouling in water quality sensors that does not require the use of chemical antifouling agents or a mechanical cleaning apparatus.

In accordance with teachings of the present disclosure, an anti-fouling system for a water quality monitoring system is disclosed that reduces or elements the problems associated with prior antifouling systems and methods by using ultraviolet light sources to reduce the development of biota in the system.

In one aspect, an anti-fouling system is described for use with a water quality monitoring sensor that includes a housing with an interior cavity sized for housing a monitoring sensor. The interior cavity also includes multiple ultraviolet light sources disposed within the interior cavity that are able to reduce biota within the interior cavity. In a particular embodiment, the ultraviolet light sources are ultraviolet LEDs.

In another aspect, a method for reducing fouling in a monitoring system includes providing a monitoring sensor installed within a flow cell and providing multiple ultraviolet light emitting diodes within the flow cell. The method also includes activating the light emitting diodes to reduce fouling within the flow cell. More particularly, the sensor may be a conductivity sensor, a salinity sensor, a pH sensor, a turbidity sensor, a chlorophyll sensor, or a dissolved oxygen sensor.

The present invention contains a number of important technical advantages. One important technical advantage is including multiple ultraviolet light sources able to reduce biota within the flow cell or interior cavity. The ultraviolet light sources help prevent fouling within the sensor housing without the use of chemical antifouling agents or mechanical antifouling devices. The use of ultraviolet light sources is particularly advantageous for water monitoring sensors deployed in natural water environments. Additional technical advantages are described in the FIGURES, description and claims.

## BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present embodiments and advantages thereof may be acquired by referring to the following description taken in conjunction with the accompanying drawing, in which like reference numbers indicate like features, and wherein FIGURE 1 is a diagram of a sensor housing utilizing

ultraviolet LED's to prevent fouling according to teachings of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The preferred embodiments and their advantages are best understood by reference to FIGURE 1 wherein like numbers are used to indicate like and corresponding parts.

Now referring to FIGURE 1, a diagram of an antifouling monitoring system 10 according to teachings of the present invention is shown.

Antifouling system 10 includes a sensor housing 12 having an interior sensor cavity 14 which may also be referred to as a flow cell. Housing 12 may be constructed of inexpensive plastic or similar materials and may further include a suitable deployment apparatus for retrieval and placement. Interior cavity 14 is preferably formed for housing one or more monitoring sensors 16, which may be operable to measure and record a plurality of parameters such as temperature, conductivity, salinity, pH, turbidity, chlorophyll, dissolved oxygen or any other parameter of interest in water. In some embodiments, monitoring sensor 16 may be a multi-use sensor operable to measure multiple parameters. In other embodiments, multiple monitoring sensors may be installed within interior cavity 14.

Antifouling system 10 also includes a pump 24 with an intake inlet 20 proximate the exterior of housing 12 and an outlet 26 entering the cavity of the housing such that the pump may transfer water fluid from the exterior

of the housing 12 into housing cavity 14. In the present embodiment, pump 24 is preferably incorporated into housing 12. Also in the present embodiment, pump 24 is operably coupled to a power source (not expressly shown) suitable for supplying power to pump 24. The power source may be incorporated into the body of housing 12 or may be located outside of housing 12.

Interior cavity 14 of antifouling system 10 is preferably an opaque flow cell for surrounding monitoring sensor 16. In the present embodiment, antifouling system 10 preferably includes a plurality of ultraviolet light sources 18 within interior cavity 14 of housing 12. In one preferred embodiment, the light sources 18 are ultraviolet light-emitting diodes (LEDs) arranged in one or more arrays. Ultraviolet light sources 18 are preferably powered by a power source (not expressly shown). In one particular embodiment, ultraviolet light sources 18 and pump 24 are powered by the same power source.

In the present embodiment, pump 24 is a filtered pump for moving fluid to sensor housing 12 while excluding larger sedimentary particles. A filter such as high-surface-area screen 22 may preferably be disposed on pump inlet 20 for reducing backpressure. Screen 22 is preferably sized to remove particles not affecting the measurements of monitoring sensor 16. Pump 24 may also be reversible in order to facilitate cleaning screen 22. Pump 24 is preferably sized to generate sufficient flow to prevent accumulation of small-particle sediment in

flow cell 14, and to provide flow to any sensors that require flow to function properly.

Flow cell 14 is preferably opaque and acts to surround sensors 16 in order to prevent or reduce light from entering flow cell 14, thereby preventing the growth and reproduction of photosynthetically-active biota within flow cell 14. The opaque flow cell 14 also retains the water necessary to prevent harmful dehydration of sensors 16.

The antifouling system 10 preferably utilizes a plurality of ultraviolet light-emitting diodes (LEDs) 18 to reduce the presence of biota such as algae, fungi, and bacteria that form disruptive coatings on the sensors. LEDs 18 may preferably include high-efficiency Ultraviolet LEDs and are preferably powered by the power source that powers monitoring sensor 16 and/or pump 24. Alternatively, other ultraviolet light sources suitable for reducing biota within flow cell 14 may be used.

In operation, monitoring sensor 16 is disposed within the flow cell 14 such that the sensor 16 is enclosed within the flow cell 14. When it is desired to test a sample of water, pump 24 transmits sample into cavity 14 and measurements are taken by sensor 16. After measurements have been taken by sensors 16, pump 24 is stopped and an array of ultraviolet LEDs 18 is activated to kill or substantially reduce algae, fungi, or other harmful biota thereby reducing the likelihood of fouling within system 10. In alternative embodiments, the array of ultraviolet LEDs 18 may be periodically illuminated to

further prevent the development of algae, fungi, or other biota.

Antifouling system 10 prevents sedimentary materials from reaching the sensor by using a filtered pump 24 and inlet screen 20. Also biological materials are prevented from accumulating on the sensors 16 using ultraviolet light sources that minimize the cost, size and power consumption of the system.

Additionally, the present antifouling system 10 allows sensors 16 to be kept clean without mechanical contact, and high-friction moving parts are reduced along with their corresponding power requirements and susceptibility to failure. The result is extending the period in which the sensors can operate without mechanical or biological fouling, thereby reducing the labor cost associated with operating and maintaining the sensor.

Although the disclosed embodiment has been described in detail, it should be understood that various changes, substitutions and alterations can be made to the embodiment without departing from the spirit or scope of the invention.

WHAT IS CLAIMED IS:

1. A water quality monitoring system comprising:

a housing having an interior cavity formed for disposing a monitoring sensor and;

a plurality of ultraviolet light sources disposed within the interior cavity and operable to reduce biota within the interior cavity.

2. The system of Claim 1 wherein the interior cavity further comprises an opaque interior cavity.

3. The system of Claim 1 further comprising:

a reversible pump having an inlet and outlet operable to transmit fluid into the interior cavity; and

a screen disposed proximate the pump inlet.

4. The system of Claim 1 wherein the ultraviolet light sources further comprise ultraviolet LEDs.

5. The system of Claim 1 further comprising a conductivity sensor disposed within the housing.

6. The system of Claim 1 further comprising a salinity sensor disposed within the housing.

7. The system of Claim 1 further comprising a pH sensor disposed within the housing.

8. The system of Claim 1 further comprising a turbidity sensor disposed within the housing.

9. The system of Claim 1 further comprising a chlorophyll sensor disposed within the housing.

10. The system of Claim 1 further comprising a dissolved oxygen sensor disposed within the housing.

11. The system of Claim 1 further comprising the housing constructed from a plastic material.

12. The system of Claim 1 further operable to periodically activate the plurality of ultraviolet light sources.

13. The system of Claim 1 further comprising disposing at least two sensors within the housing.

14. A method for reducing fouling in a monitoring system comprising:

providing a monitoring sensor disposed within a flow cell;

providing a plurality of ultraviolet light emitting diodes within the flow cell; and

activating the light emitting diodes to reduce fouling within the flow cell.

15. The method of Claim 4 further comprising periodically activating the light emitting diodes.

16. The method of Claim 4 further comprising activating an associated pump operable to pump water from outside the flow cell to inside the flow cell.

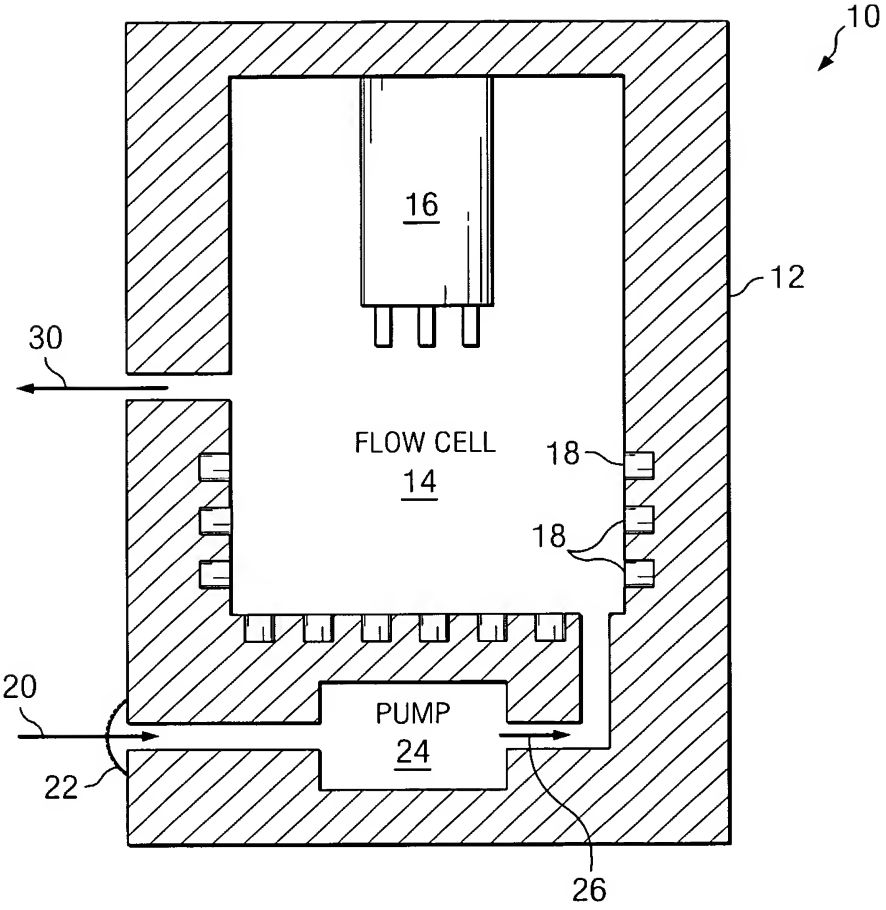
17. The method of Claim 4 further comprising reversing the flow of the pump prior to pumping water into the fuel cell operable to remove collected material from an associated pump inlet screen.

18. The method of Claim 13 further comprising disposing a sensor within the flow cell.

19. The method of Claim 18 further comprising selecting the sensor from the group consisting of a conductivity sensor, a salinity sensor, a pH sensor, a turbidity sensor, a chlorophyll sensor, and a dissolved oxygen sensor.

20. The method of Claim 18 further comprising disposing at least two sensors within the housing.

*FIG. 1*



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TITLE: Water quality monitoring system for preventing fouling in water quality sensors, comprises housing having interior cavity formed for disposing monitoring sensor, and ultraviolet light sources disposed in interior cavity

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BASIC-ABSTRACT:

NOVELTY - A water quality monitoring system (10) comprises a housing (12) having an interior cavity (14) formed for disposing a monitoring sensor (16), and ultraviolet light sources (18) disposed in the interior cavity and operable to reduce biota in the interior cavity.

DESCRIPTION - An INDEPENDENT CLAIM is also included for reducing fouling in a monitoring system comprising providing a monitoring sensor located in a flow cell, providing ultraviolet light emitting diodes in the flow cell, and activating the light emitting diodes to reduce fouling in the flow cell.

USE - Used for preventing fouling in water quality sensors.

ADVANTAGE - The system does not require the use of chemical antifouling agents or mechanical cleaning apparatus.

DESCRIPTION OF DRAWING(S) - The figure is a diagram of an antifouling monitoring system.

Water quality monitoring system (10)

Housing (12)

Interior cavity (14)

Monitoring sensor (16)

Ultraviolet light sources (18)

Pump inlet and outlet (20, 26)

Screen (22)

Pump (24)

EQUIVALENT-ABSTRACTS:

MECHANICAL ENGINEERING

Preferred Component: The interior cavity further includes an opaque interior cavity. The water quality monitoring system further includes a reversible pump (24) having an inlet and an outlet (20, 26) to transmit fluid into the interior cavity, a screen (22) proximate the pump inlet, a conductivity sensor, a salinity sensor, a pH sensor, a turbidity sensor, a chlorophyll sensor, a dissolved oxygen sensor, and a housing constructed from plastic material. The ultraviolet light source further includes ultraviolet light emitting diodes (LEDs).

Preferred Process: The reduction of fouling in the monitoring system further includes periodically activating the light emitting diodes, activating an associated pump operable to pump water from outside the flow cell to inside the flow cell, reversing the flow of the pump prior to pumping water into the fuel cell operable to remove collected material from associated pump inlet screen, disposing sensor in the flow cell, selecting the sensor, and disposing sensor in housing.

CHOSEN-DRAWING: Dwg.1/1

TITLE-TERMS: WATER QUALITY MONITOR SYSTEM PREVENT FOUL SENSE COMPRISE HOUSING INTERIOR CAVITY FORMING DISPOSABLE ULTRAVIOLET LIGHT SOURCE

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